

Claims

What is claimed is:

1. An apparatus for identifying molecular structures within a sample substance, comprising:

an integrated circuit array sensor for outputting signals representative of the interaction of probe molecular structures on the surface of said sensor and target molecular structures within a sample substance (hereinafter "target");

a controller unit for interfacing with said integrated circuit array sensor and accessing said signals representative of the interaction of probe and target molecular structures;

an input/output port for communicating with control, post-processing, and data storage circuits;

a chamber, such as a hybridization chamber, for exposing sensitive area of said integrated array sensor to the sample substance; and

a means for controlling and programmable changing of the temperature of said chamber, the sample substance and said integrated array sensor.

2. The integrated array sensor of claim 1, where said sensor comprises a set of pixel circuits, each said pixel is usually not bigger than (1 mm x 1 mm) in size, and most preferably is less than (100 μ m x 100 μ m) in size;

each said pixel is capable of accumulating and processing an electric charge produced upon interaction of probe and target molecular structures on the surface of said sensor.

3. The integrated array sensor of claim 1, where said sensor comprises an array of active pixels, each said pixel has one or more active transistors within the pixel unit, and each said pixel has a connection with a multiple column readout circuit, similar to the architecture implemented by Complementary Metal Oxide Semiconductor (CMOS) array imagers. Said active pixels are capable of converting the electric charge accumulated by said pixels into an output electronic signal.

4. Alternatively, the integrated array sensor of claim 1, where said sensor comprises an array of pixels capable of accumulating, storing, and transferring an electric charge to a readout register formed in the sensor's substrate, similar to the design implemented by a Charge-Coupled Device (CCD). Said pixels and readout circuits are capable of converting an electric charge accumulated by said pixels into an output electronic signal.
5. The chamber of claim 1, where said chamber is attached thereto to the sensitive area of said integrated array sensor such that filling said chamber with a sample substance exposes the sensitive area of the integrated array sensor to that sample substance.
6. The means for controlling and changing temperature of claim 1, where said means allows maintaining a constant preprogrammed temperature of the sample substance and said integrated array sensor, or alternatively, said means allows running a preprogrammed change of temperature versus time such as, for example, gradually increasing or decreasing the temperature, or a stepwise change of temperature. Said means for controlling and changing temperature also are capable of providing an electronic output versus time representative of the temperature of the sample substance and the integrated array sensor.

7. A method for identifying molecular structures within a sample substance, comprising the steps of:

- (a) applying the substance to a plurality of test sites formed on a surface of said integrated circuit array sensor, said test sites having respective probes attached thereto which specifically bind to a target molecular structure, such that different test sites have probes which specifically bind to different target molecular structures;
- (b) maintaining a constant preprogrammed temperature of the substance and said integrated circuit array sensor, or alternatively, running a preprogrammed temperature profile such as, but not limited to, gradually increasing or decreasing the temperature or, for example, stepwise changing of the temperature of the sample substance and said integrated array sensor;
- (c) acquiring an electronic signal from a plurality of the pixels associated with the test sites, each test site covering at least one pixel of said integrated array sensor;

- (d) detecting the amplitude of the electronic signals versus time from the test sites to determine which probes have interacted with an associated target molecular structure such that a plurality of different targets can be detected.
8. The method of claim 7 wherein said probes are oligonucleotide probes or their analogous equivalent known to one skilled in the art.
9. The method of claim 7 wherein said probes are antibody pieces.
10. The method of claim 7 wherein said probes are ligands or ligand analogs capable of binding to proteins.
11. The method of claim 7 wherein said probes are protein or peptide probes.
12. The method of claim 7 wherein said detection step comprises detecting an electronic signal at a constant temperature of the sample substance and said integrated array sensor.

13. The method of claim 7 wherein said detection step comprises detecting an electronic signal during a stepwise change of the temperature of the sample substance and said integrated array sensor.
14. The method of claim 7 wherein said detection step comprises detecting an electronic signal during a gradual change of the temperature of the sample substance and said integrated array sensor.
15. The method of claim 7 wherein said detection step comprises detecting an electronic signal versus time for each probe site, therefore providing identification of the sample substance based upon the rate of a rising or falling electronic signal versus time due to forming or, equally acceptable, breaking of probe-target duplexes of the probe and target molecular structures.
16. The method of claim 14 wherein said detection step comprises detecting an electronic signal for each probe site versus the temperature, therefore providing said identification of the molecular structures of the sample substance based on the specific temperature of binding, or equally acceptable, based on the specific temperature of melting of probe-target duplexes.